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Level 1 Assessment of Uncontrolled Q-BOP Emissions

Research Triangle Inst, Research Triangle Park, NC

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Industrial Environmental Research Lab, Research Triangle Park, NC

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Agency

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

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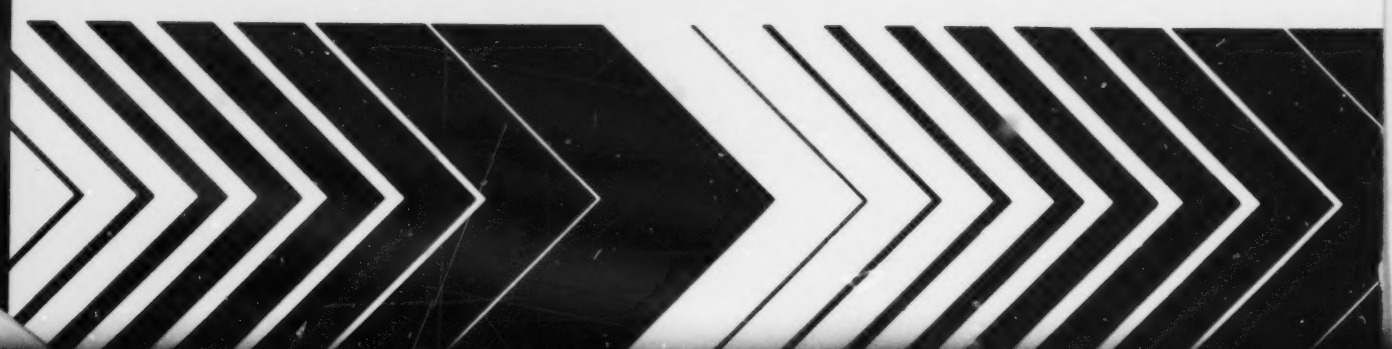

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16. ABSTRACT

The report gives results of sampling and analysis of uncontrolled emissions from a Q-BOP, a bottom-blown Basic Oxygen Process for steelmaking, undertaken to characterize and quantify the particulate, organic, and inorganic species emitted during hot metal addition to precharged scrap metal. Sampling was in the secondary emission collection system before the emission control equipment and was conducted using EPA Level 1 Environmental Assessment Methodology. Particulate concentration was 1298 mg/cu m and total organic emissions were 64.1 mg/cu m. About 75% of this material was high molecular weight organics. The less than 3 micrometer solids contain over half of all the organics emitted. Although the presence of several carcinogenic polycyclic organic compounds was suggested by the LRMS analysis, GC-MS analysis showed that no known carcinogenic compounds were in the emissions. SSMS analysis indicated that eight elements might exceed Air-Health MATE values if emitted uncontrolled. Calculated control levels needed range from 63 to 99.6%.

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Steel Making		Q-BOP Process	13H	
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by

C. W. Westbrook

Research Triangle Institute
P. O. Box 12194
Research Triangle Park, N.C. 27709

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Industrial Environmental Research Laboratory
Office of Environmental Engineering and Technology
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The efforts of Dr. Robert Handy of RTI, who directed the organic work and interpreted the IR and LRMS spectra are also appreciated. Appreciation is also expressed to Republic Steel Corporation for their cooperation and assistance with this project.

1.0 INTRODUCTION

Q-BOPs, bottom blown Basic Oxygen Process for steelmaking, are of interest to the Environmental Protection Agency (EPA) because of their potential for high particulate and organic compound emissions. Of particular interest are emissions generated during the hot metal addition to precharged scrap metal. Information was needed to characterize the emission of inorganic and organic components during this phase of the Q-BOP steelmaking process. To supply this data, Acurex Corporation was assigned by EPA the task of sampling the emissions from the charging operation (before entering the air pollution control equipment) at Republic Steel Corporation's, Chicago, Illinois plant. The Research Triangle Institute (RTI) was responsible for the analysis of the collected samples.

This report, prepared by Research Triangle Institute, integrates the process description, details of the sampling program and data obtained during sampling--all of which are provided by Acurex Corporation in final report form, observations and data collected by RTI personnel, and results of RTI's chemical analyses.

Section 2 presents conclusions made by RTI based on the test data. Section 3 presents a description of the test, including the facility, process, and sampling protocol used and Section 4 gives details of the test results. The Appendices contain details of the analytical results and observations made during the test.

2.0 CONCLUSIONS

This test at a Q-BOP was conducted to determine if potentially hazardous materials are produced during the hot metal addition cycle of the process. Tests were conducted by IERL-RTP Level 1 procedures in the secondary emission collection system during eight hot metal additions (four process cycles).

The particulate emissions are given in Table 1. During the brief period of actual hot metal addition, particulates are emitted at a fairly high rate (1300 mg/m^3). Emissions are not excessive, however, when calculated on a Kg/ton of charge or Kg/cycle basis. Data in Table 11, Section 4 show that about 69 percent of the particulate is greater than 10 microns and 14 percent falls in the 1-3 μ size. It is important to realize that testing occurred only during actual hot metal addition. Thus these results do not reflect emissions which occur during the O_2 blow cycle or during other periods when the vessel is turned down (i.e., scrap charge, metal sampling, etc.) or the brief period between hot metal addition from the two ladles.

TABLE 1. SUMMARY OF PARTICULATE DATA--UNCONTROLLED EMISSIONS

Stack Gas Volumetric Flowrate, m^3/min	11,495*
Particulate Concentration, mg/m^3	1,300
Particulate Generated, Kg/min	14.9
Kg/average cycle (257 tons charged)	32.9
Kg/ton hot metal added (average)	0.16
Kg/ton steel scrap (average)	0.64
Kg/ton of total charge	0.13

*Average flowrate during preliminary tests was 9,372 m^3/min which is consistent with system design value.

Total organic content of the uncontrolled emissions is given in Table 2. About 50 percent of the 64.1 mg/m^3 total organics was associated with the <3 μ dusts. The XAD-2 resin captured about 30 percent of the total with the balance in the probe and cyclone rinses. High boiling point (GRAV) material accounted for about 75 percent of the organic material. Aliphatic hydrocarbons were the predominate species emitted. Fused aromatics over 216 mw were also emitted at high levels (~5 mg/m^3). The emissions also contain alcohols, amines, amides, esters, and carboxylic acids. The Low Resolution Mass Spectrograph (LRMS) analysis (Appendix A) contain several molecular weights that could be associated with carcinogenic material however, GC-MS analysis indicates these components are fragments of high molecular weight organics and not known carcinogens. Comparison of the organic category concentrations with Air-Health MATE values indicates that control is needed for fused aromatics (96 percent), amines (~50 percent), and carboxylic acids (~50 percent).

TABLE 2. SUMMARY OF ORGANIC DATA--UNCONTROLLED EMISSIONS

Stack Gas Volumetric Flowrate, m^3/min		11,495*
Total Organic Concentration, mg/m^3		64.1
Organic Generated, Kg/min		0.74
	Kg/average cycle (257 tons charged)	1.6
	Kg/ton hot metal added (average)	0.0079
	Kg/ton steel scrap (average)	0.031
	Kg/ton of total charge	0.0063

*Average flowrate during preliminary tests was 9,372 m^3/min which is consistent with system design value.

A summary of inorganic emissions is given in Table 16, Section 4. These data indicate that the uncontrolled discharge of emissions generated during hot metal addition would exceed Air-Health MATE values for nickel, iron, chromium, calcium, arsenic, lead, and possibly sulfur and phosphorus. To meet these criteria, a control efficiency of, respectively, 92, 89-99, 99.6,75, 90, 63, 0-87, and 0-81 percent might be required.

Table 3 gives the distribution of these elements in the different SASS train samples. Only sulfur and phosphorous would not be substantially removed by collection of the particulate matter.

TABLE 3. DISTRIBUTION OF INORGANICS EXCEEDING MATE VALUES

	Ni	Fe	Cr	Ca	As	Pb	S	P
1PW	53	14	65	5	30	13	4	5
1C310	7	85	28	41	46	13	5	26
1C1	7	--	3	54	18	59	15	2
1X	--	--	--	--	5	15	72	66
1 IMP 1	34	--	5	--	--	--	4	--

[a]As percent of total emitted.

The data obtained in this test supports the conclusions that:

1. Particulates are produced in high concentration during hot metal addition.
2. Organics are emitted in surprisingly high concentrations.
3. About 50 percent of the organic matter is associated with the <3 μ particulates.
4. Fused aromatics, amines, carboxylic acids, and several inorganic elements are generated at sufficiently high levels that some degree of control may be needed.
5. Fused aromatics are predominately >216 mw but appear to contain no carcinogenic material.

3.0 TEST DESCRIPTION

Contained in this Section is a description of the Q-BOP facility tested, process and operating data, the sampling data obtained, and sampling protocol used.

3.1 Q-BOP FACILITY, REPUBLIC STEEL, CHICAGO, ILLINOIS

The Q-BOP shop at Republic Steel, Chicago contains two vessels each rated at 225 tons/heat. Six to eight heats can normally be completed in an eight hour shift. Figure 1 is a schematic of the Q-BOP vessel and ancilliary equipment. A schematic of the emissions control system is in Figure 2.

The Q-BOP vessel differs from the conventional BOF by introducing oxygen through tuyeres in the bottom of the vessel rather than through a lance above the charged material. Introducing oxygen in this way may result in better control of the steelmaking process.

As illustrated in the Figures, each vessel is in a separate enclosure (referred to as a "doghouse") and is connected to separate gas collecting and cleaning systems. Each gas collecting system consists of two separate systems--a primary system to collect the emissions during oxygen blow and a secondary system to collect emissions during the addition of scrap and hot metal, tapping, slagging, and when the vessel is idle. The emissions collected by the primary and secondary systems enter a common (for each vessel) gas cleaning system (wet scrubber).

At the start of a heat, the vessel is tilted, the enclosure doors opened, and a charge of scrap metal added. While the vessel is being charged, nitrogen (or a natural gas/air mixture) is blown through the tuyeres in the vessel bottom to prevent plugging. As soon as the vessel is tilted more than 20°, the secondary hood collection system is automatically actuated while the primary system is decreased to about 10 to 20 percent of full capacity by adjusting dampers in the respective ductworks. In addition, the damper isolating both secondary collection systems is opened which allows both ID fans to exhaust

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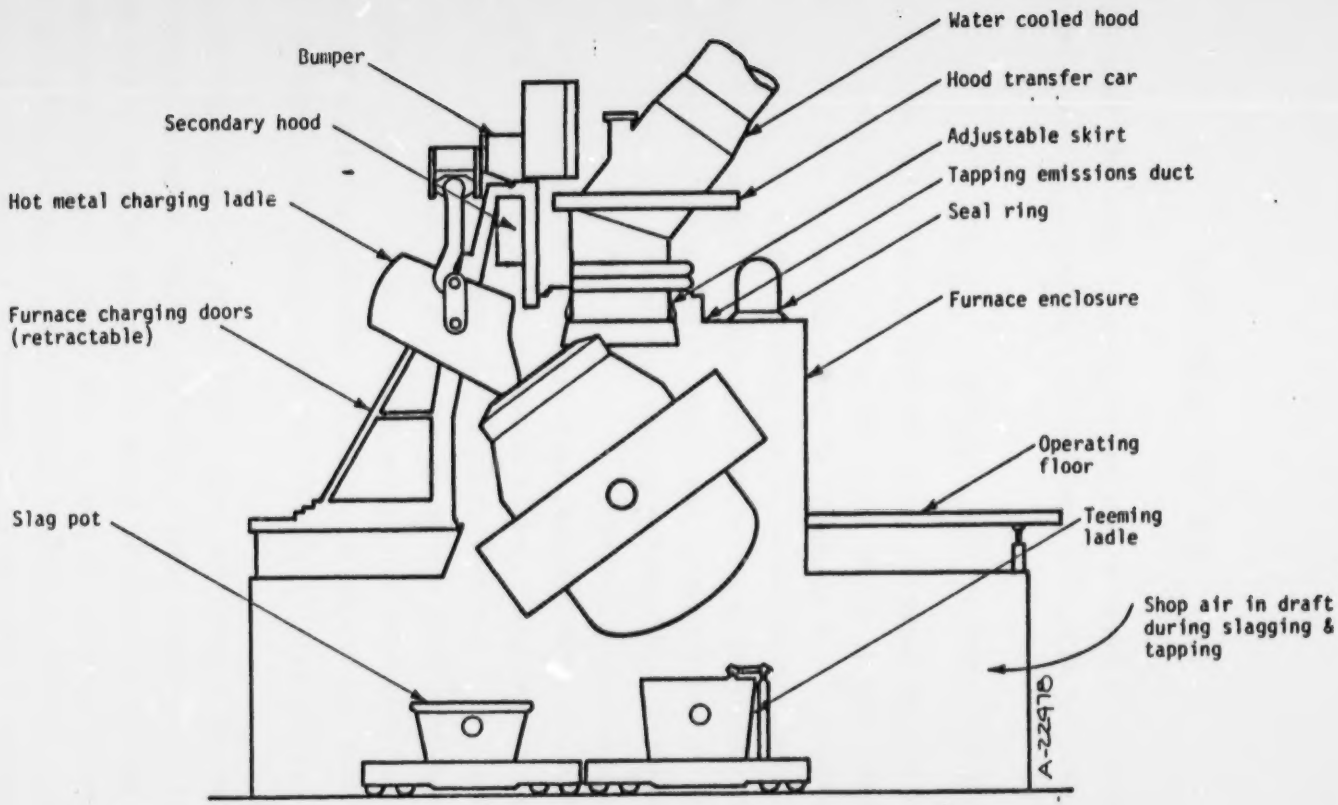


Figure 1. Schematic of Q-BOP vessel.

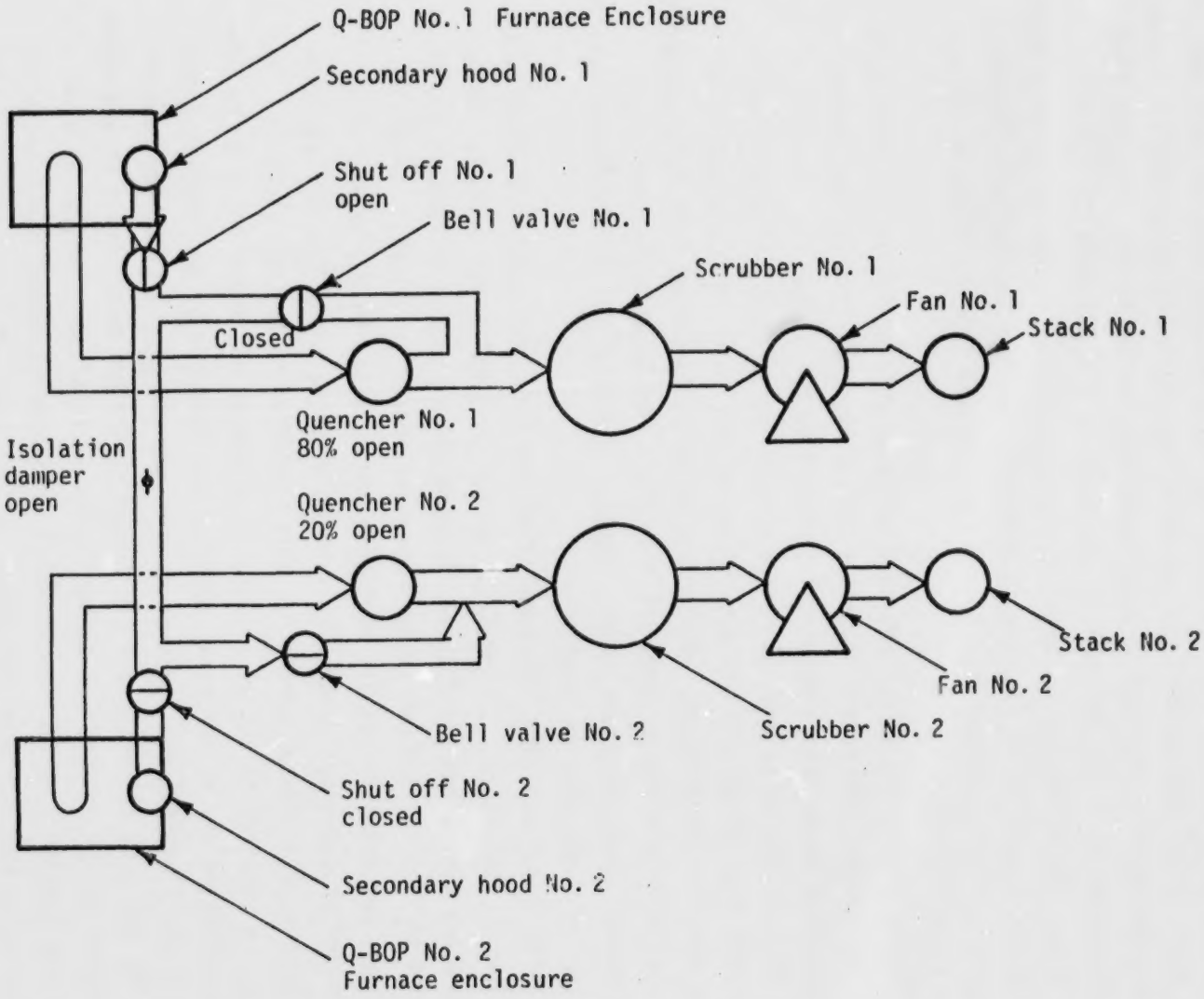


Figure 2. Q-BOP emission control system.

gas from the secondary hood and vessel enclosure. The design operating point for a fan for the secondary collection system is 272,000 acfm at 120°F and -86 in. water (7704 acmm at 49°C and 160 mm of Hg, fan inlet conditions). Acurex's conversion of this flowrate to conditions anticipated in the secondary hood yielded a value of 209,000 acfm (5,920 acmm) or 418,000 acfm (11,840 acmm) for two fans. PECOR (system designer) estimated leakage through the primary hood system and quench at 44,000 acfm (1,246 acmm) leaving 374,000 acfm (10,594 acmm) to actually collect fume during charging and tapping (referred to as high fixed flowrate).

Scrap preheating is not employed although the capability has been built into the system. Occasionally, scrap with a high moisture content may be dried with a purge before hot metal is added to the vessel.

Most of the scrap used is revert or mill scrap (e.g., rejected ingots, crop ends from blooms and billets, blast furnace molds, etc.) which is of known chemical composition. Number one scrap is purchased from outside suppliers and typically consists of material from steel consuming industries (e.g., appliances, steel furniture, beams, angles, channels, etc.). Pit scrap (spillage, skulls, etc.) may also be used.

After scrap addition, hot metal from the blast furnace, if available, can be added to the vessel. If hot metal is not available, the doors to the enclosure are closed and the flowrate through the secondary collection system is reduced to "low fixed flow" (occurs whenever vessel is idling). Generally speaking, hot metal is usually available and is added to the vessel using ladles and an overhead crane. The rate at which N_2 (only N_2) is blown into the tuyeres is increased during hot metal addition to prevent plugging. Two ladles are required to charge a vessel with enough hot metal for a heat. The fumes generated during hot metal addition are captured by the secondary hood (high fixed flowrate) and are sent to both gas cleaning systems for removal.

The doors to the enclosure are closed as the hot metal ladle is withdrawn. The vessel is now charged and turned to the vertical position for O_2 blow. Since the secondary collection system is activated by vessel position, it is automatically shut off when the vessel is less than 20° from vertical. The isolation damper is closed and the valve in the primary collection is opened.

As soon as the vessel reaches the vertical position, the moveable hood is lowered to the mouth of the vessel, the N_2 purge is shut off and O_2 is blown through the tuyeres. The O_2 blow rate is constant and does not vary during a heat. The length of the O_2 blow varies from approximately 12 to 15 minutes depending on the grade of steel being made. Once the O_2 blow flowrate has been established, fluxes are blown into the vessel through the tuyeres. Rough estimates of fluxes added are: burnt lime 30,000 to 35,000 lbs., dolomitic lime 6,000 to 7,000 lbs., and fluorspar 2,000 to 3,000 lbs. The amount of additions vary but are known and recorded in the pulpit. This suppressed combustion process produces a CO-rich gas and hence O_2 infiltration into the system is dangerous (explosion could result). Sensors located downstream of the ID fan measure the amount of CO and O_2 in the system. Should O_2 enter the system upstream of the ID fan, O_2 blow is terminated and N_2 is blown through the tuyeres. Also, an N_2 purge of the ductwork is activated until a safe operating condition is reached.

After completing the O_2 blow, the vessel is turned down for temperature. The secondary collection system is activated and the doors of the enclosure are opened just enough for an operator to insert the thermocouple into the vessel. If the metal temperature is too low, an O_2 reblow may be necessary. If the metal temperature is too hot, N_2 and/or dolomitic lime can be blown into the system to produce the desired cooling effect. If the metal temperature is right, an operator takes a sample of the metal for chemical analysis. The time consumed during this turndown is approximately 5 minutes and the secondary collection system is in operation.

The vessel is now ready to be tapped. Tapping time varies with the size of the tap hole but is normally 5 minutes. The vessel is tapped into a ladle and additional agents are added directly to the ladle to produce the desired chemical composition. The temperature of the molten steel is also measured and recorded. Again, the secondary collection system was actuated as soon as the vessel was turned down to the tap position (doors on "doghouse" closed).

Occasionally, (one heat in six) the vessel is "shot" by the operator. This process involves the introduction of N_2 and dolomitic lime into the tuyeres to splatter the slag remaining in the vessel onto its walls to coat the lining. After this operation has been completed, the vessel is rotated

through the vertical position and down to the slag position ("doghouse" doors closed). The slag in the vessel is poured into a ladle under the operating floor and the vessel is now ready for another heat.

Collected emissions are quenched by water sprays and cleansed in a water scrubber. Pressure drop across the scrubber is about 75 in. of water (140 mm Hg). Water recirculation rate is about 2500 gpm. Scrubber effluent water, about 250 gpm, is treated with flocculants and clarified prior to recycle. The solids removed are presently stored on plant property. Attempts to recycle these solids by briquetting have not been very successful.

3.2 SAMPLING EQUIPMENT PREPARATION AND SAMPLE RECOVERY

The test equipment used was the Source Assessment Sampling System (SASS). Table 4 details the procedures used to clean the system prior to the test run. All solvents used were Mallinckrodt Nanograde reagent except the methylene chloride (J. T. Baker Instra Analyzed). The 30 percent peroxide (H_2O_2), ammonium persulfate, and silver nitrate were Mallinckrodt Analytical Grade reagents. Deionized water was from Hinckley and Schmitt.

The partially assembled system was sealed with aluminum foil and transported to the test site. The complete system was then assembled, leak checked, and impinger solutions added. All system components had been calibrated prior to the testing.

Prior to the SASS test, Acurex conducted a 24 point velocity and temperature traverse across the secondary emission collection duct during simulated hot metal addition conditions. The observed gas flowrate was 330,887 dscfm (9,372 dscmm) or 368,038 acfm (10,424 acmm) which compares well with the design value of 374,000 acfm (10,593 acmm). A nozzle size of 0.3750 in. (0.95 cm) was selected for the SASS test.

The SASS test was conducted at a single point (mid-point) in the secondary hood duct only 1/2 of a stack diameter upstream of the downcomer to the twin venturi quencher and 1.5 diameters downstream of a bend in the duct. Flowrate through the SASS train was about 4 scfm (0.11 scmm) to insure proper separation of particulates in the cyclones. The probe and oven were maintained at 204°C

TABLE 4. SASS TRAIN CLEANING PROCEDURES

SASS Train Component	Cleaning Procedures						
	Wash, Brush Soap, Water	Tap Water Rinse	15% HNO_3 Acid Soak	DI Water Rinse	Methanol Rinse	Methylene Chloride Rinse	Isopropanol Rinse
Sampling nozzle	X	X	X	X	X	X	
5-ft glass-lined probe	X	X	X	X	X	X	
10μ cyclone and cup	X	X	X	X	X	X	
Connector tube	X	X	X	X	X	X	
3μ cyclone and cup	X	X	X	X	X	X	
Connector tube	X	X	X	X	X	X	
1μ cyclone and cup	X	X	X	X	X	X	
Connector tube	X	X	X	X	X	X	
142 mm filter holder	X	X	X	X	X	X	
Teflon-lined hose	X	X	X	X	X	X	
Organic module and condensate jar	X[†]	X	X	X	X	X	
Teflon-lined hose	X	X	X	X			X
Impingers, connectors, and stems	X	X	X	X			X

(400°F), considerably above the stack gas temperature of about 65°C (150°F). The XAD-2 cartridge and impinger train were maintained, respectively, at 15°C (60°F) and 21-27°C (70-80°F). The SASS sampling procedures are outlined in Table 5.

The sample point location is shown in Figure 3. Data acquired during the test are shown in Figure 4. Level 1 sampling procedures normally require the collection of 30 m^3 (1000 ft^3) of gas; however, this volume of gas was not collected since the hot metal addition portion of the Q-BOP cycle is only 1 to 2 minutes in length. A total of eight separate hot metal additions to the Q-BOP vessel were sampled during the test.

Tables 6 and 7 indicate the sample recovery procedures used by Acurex. Table 8 gives the details of the scrap and hot metal addition rates.

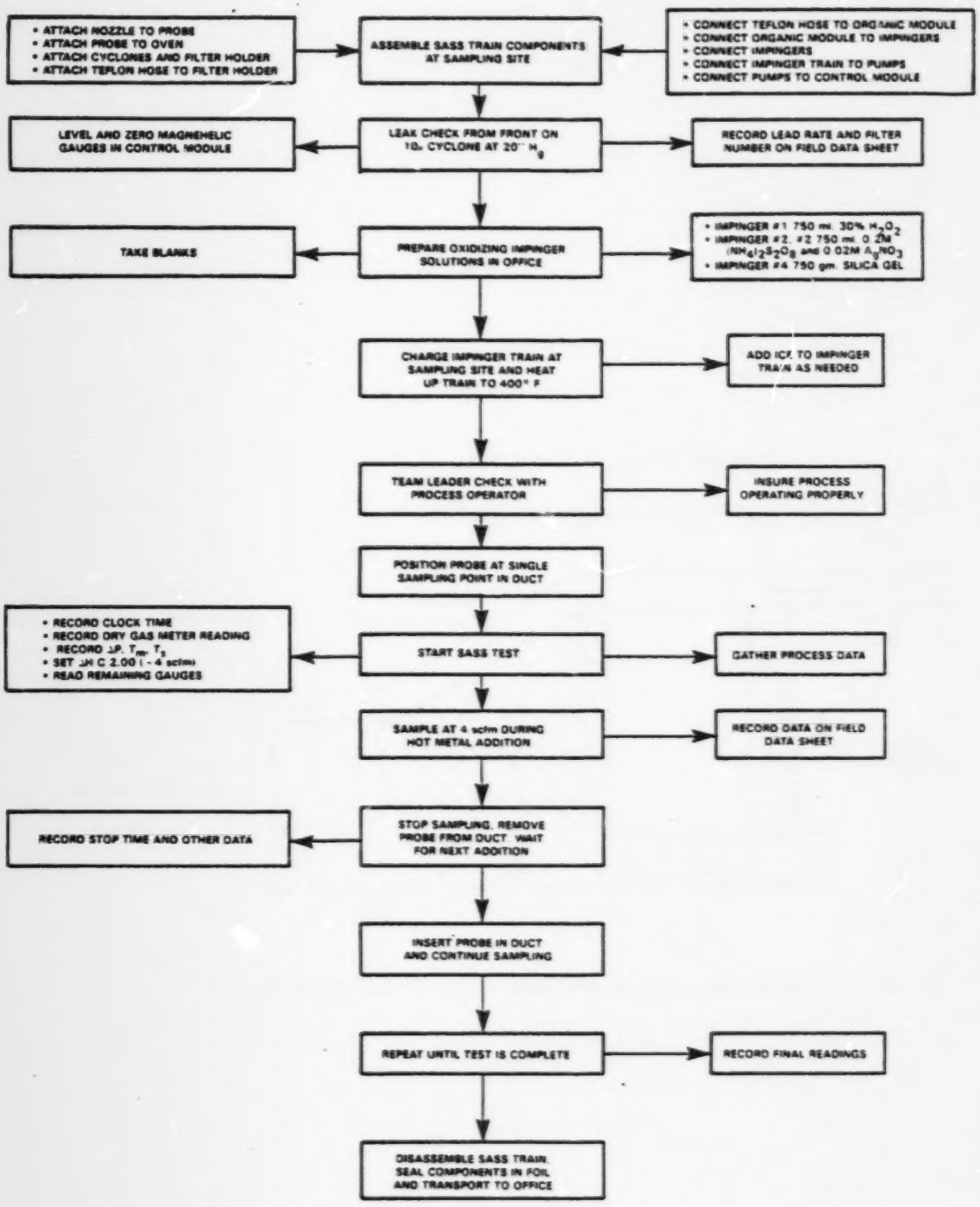

• ATTACH NOZZLE TO PROBE
• ATTACH PROBE TO OVEN
• ATTACH CYCLONES AND FILTER HOLDER
• ATTACH TEFLON HOSE TO FILTER HOLDER
ASSEMBLE SASS TRAIN COMPONENTS AT SAMPLING SITE
• CONNECT TEFLON HOSE TO ORGANIC MODULE
• CONNECT ORGANIC MODULE TO IMPINGERS
• CONNECT IMPINGERS
• CONNECT IMPINGER TRAIN TO PUMPS
• CONNECT PUMPS TO CONTROL MODULE
LEVEL AND ZERO MAGNEHELIC GAUGES IN CONTROL MODULE
LEAK CHECK FROM FRONT ON 10μ CYCLONE AT 20" Hg
RECORD LEAD RATE AND FILTER NUMBER ON FIELD DATA SHEET
TAKE BLANKS
PREPARE OXIDIZING IMPINGER SOLUTIONS IN OFFICE
• IMPINGER #1 750 ml. 30% H_2O_2
• IMPINGER #2, #3 750 ml. 0.2M $(NH_4)_2S_2O_8$ and 0.02M $AgNO_3$
• IMPINGER #4 750 gm. SILICA GEL
CHARGE IMPINGER TRAIN AT SAMPLING SITE AND HEAT UP TRAIN TO 400° F
ADD ICE TO IMPINGER TRAIN AS NEEDED
TEAM LEADER CHECK WITH PROCESS OPERATOR
INSURE PROCESS OPERATING PROPERLY
POSITION PROBE AT SINGLE SAMPLING POINT IN DUCT
• RECORD CLOCK TIME
• RECORD DRY GAS METER READING
• RECORD ΔP, T_m, T_s
• SET ΔH @ 2.00 (~ 4 scfm)
• READ REMAINING GAUGES
START SASS TEST
GATHER PROCESS DATA
SAMPLE AT 4 scfm DURING HOT METAL ADDITION
RECORD DATA ON FIELD DATA SHEET
RECORD STOP TIME AND OTHER DATA
STOP SAMPLING, REMOVE PROBE FROM DUCT, WAIT FOR NEXT ADDITION
INSERT PROBE IN DUCT AND CONTINUE SAMPLING
REPEAT UNTIL TEST IS COMPLETE
RECORD FINAL READINGS
DISASSEMBLE SASS TRAIN, SEAL COMPONENTS IN FOIL AND TRANSPORT TO OFFICE

TABLE 5. SASS TRAIN SAMPLING PROCEDURES

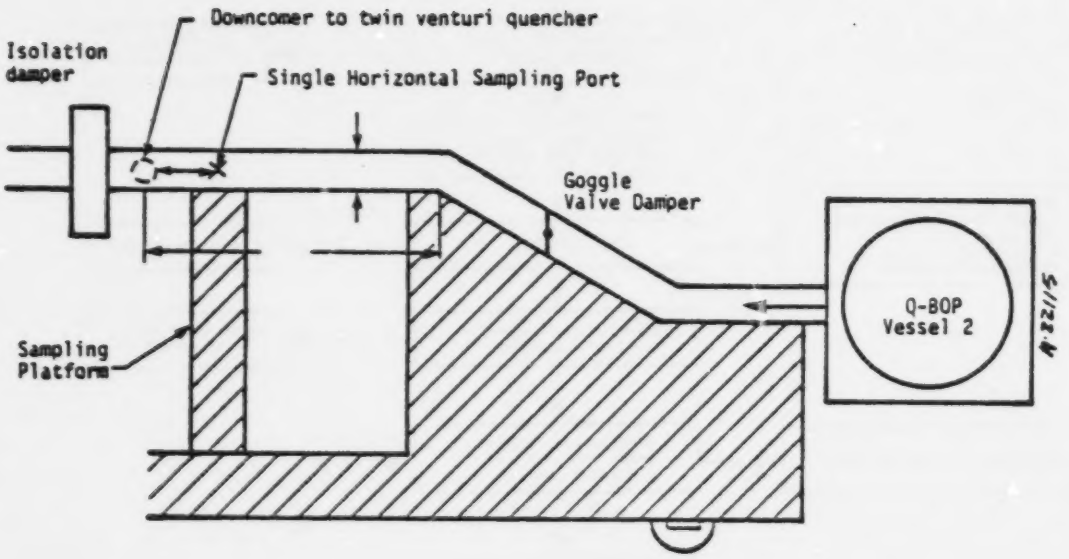


Figure 3. Sampling site on secondary gas cleaning system.

PLANT Republic Steel Corp. Chicago
LOCATION Vessel 2 Outlet
STACK DIAMETER (IN.) 120

DATE 3/15/78
TIME 11:00 a.m.
RUN SASS

OPERATORS Steiner
STATIC PRESSURE (IN.WG.) -6.5
AMBIENT PRESSURE (IN.HG.) 29.53
TYPE S PITOT COEFFICIENT 0.778

STACK PRESSURE (IN.HG.) 29.05
MOLECULAR WEIGHT (LB/LB-MOLE)
METER BOX NUMBER 0038
ORIFICE METER COEFFICIENT 3.789
PROBE LENGTH (FT.) 5' glass
NOZZLE DIAMETER (IN.) 0.275

FILTER NUMBER 178-71
LEAK RATE 0.025 @ 20"

PARTICULATE SAMPLING DATA

Heat #	Sampling Time	Sampling Point Number	Stack Gas Temp (°F)	Probe Temp (°F)	Oven Temp (°F)	Dry Gas Meter Temp Inlet (°F)	Dry Gas Meter Temp Outlet (°F)	Velocity Head (in. wg.)	Orifice Meter (in. wg.)	Gas Meter Volume (ft.³)	Organic Module Temp.	√ΔP
		4'6"	128	400	400	56	56	3.3	2.2	0	46	1.817
	1.2		147			54	54	3.5	2.4	6.187		1.871
20764												
			129	400		54	54	3.3		6.187	41	1.817
	0.7									8.828		1.817
			149	402	400	54	53	3.3	2.2	8.828	40	1.817
			156			54	53	3.4	2.2			1.844
			161			54	53	3.2	2.2			1.789
	2.1		157			54	53	3.3	2.2			1.817
										17.233		
20765												
			140	399	398	54	54	3.2	2.2	17.233	41	1.789
			162			54	54	3.4	2.2			1.844
	0.8									20.836		
			144	398	401	53	53	3.7	2.2	20.836	44	1.817
			157			53	53	3.4	2.2			1.844
	1.2		167			53	53	3.6	2.2			1.897
										25.672		
20766												
			148	399	394	53	53	3.5	2.2	25.672	42	1.871
			157			53	53	3.4	2.2			1.844
	0.65									27.973		
		4'6"	144	406	396	53	53	3.5	2.2	27.973	46	1.871
			154			53	53	3.4	2.2			1.844
			161			53	53	3.4	2.2			1.844
	1.35		162					3.4	2.2			1.844
										33.592		
20777												
			144	408	396	53	53	3.3	2.2	33.592	44	1.817
	0.8		150			53	53	3.3	2.2			1.817
			149			53	53	3.4	2.2			1.844
										36.401		
			Average 151.7			Average 53.53	Average 53.35		Average 2.22	Total 36.462		
						Average 53.45						1.836

Θ 8 min EOR

*ΔP during idle 0.65" wg
T_s during idle 130-150°F
in between ladles ΔP 2.6
T_s 100
ΔP during scrap 3"
T_s 114
in between lables 2.6
110

FIGURE 4. SASS Field Data

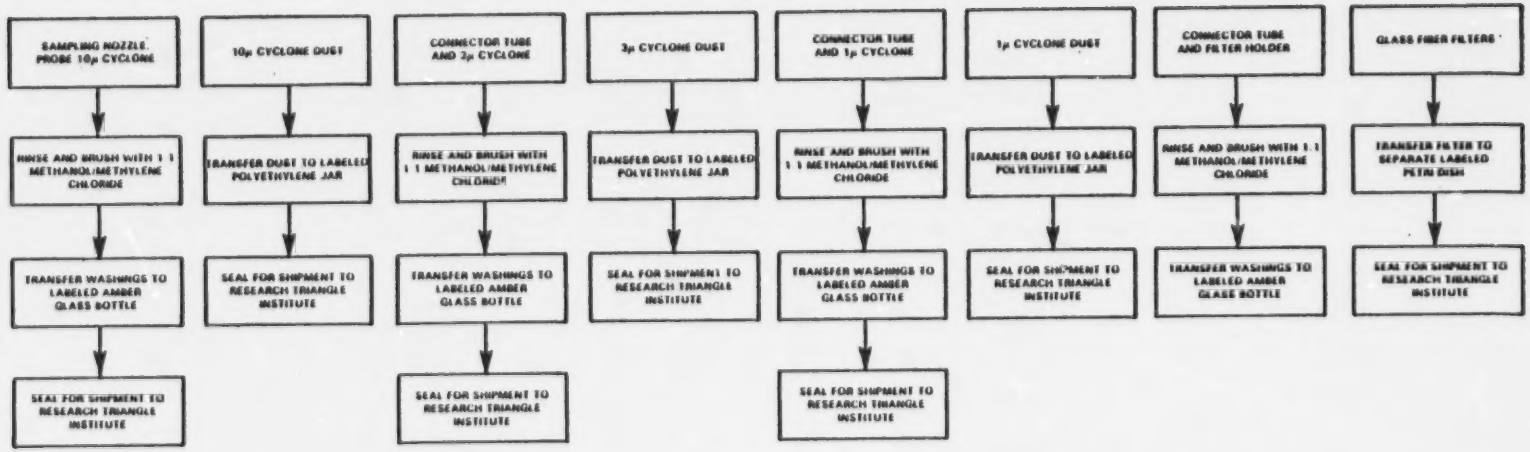
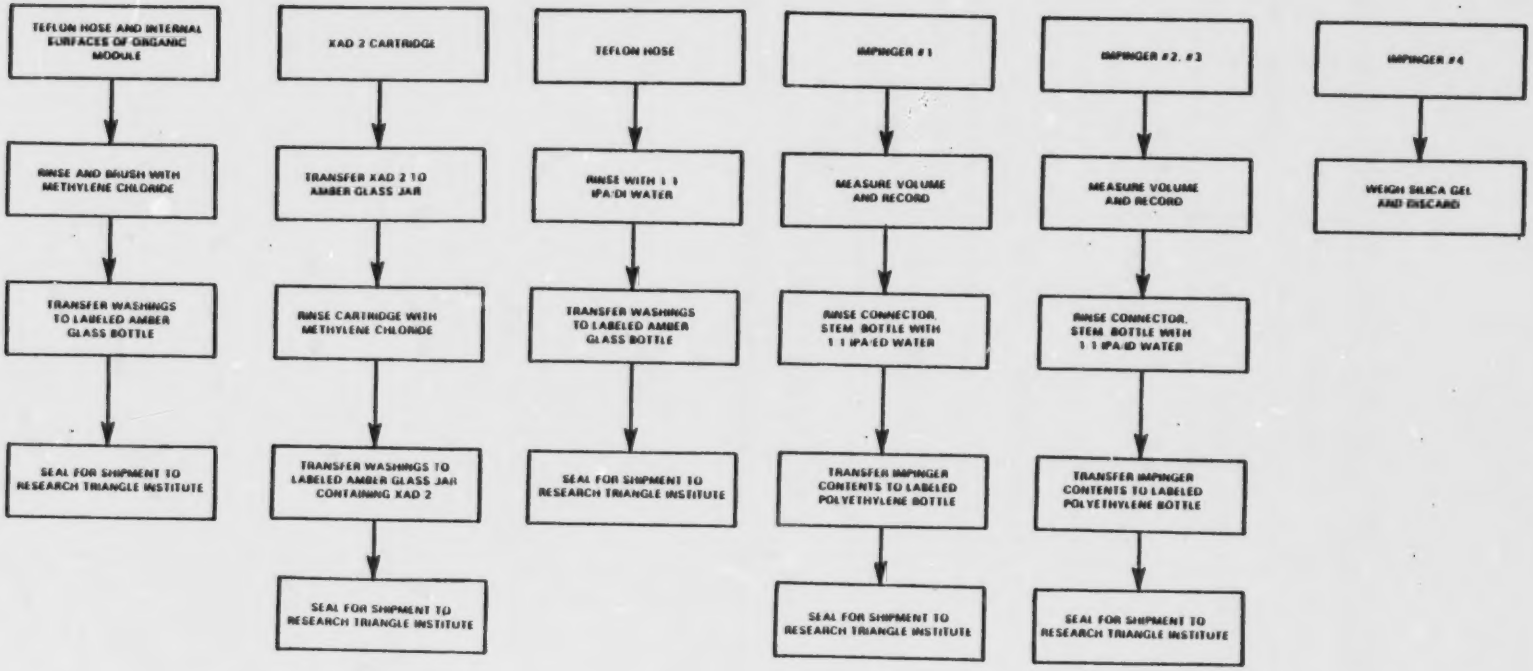

SAMPLING NOZZLE, PROBE 10μ CYCLONE
RINSE AND BRUSH WITH 1:1 METHANOL/METHYLENE CHLORIDE
TRANSFER WASHINGS TO LABELED AMBER GLASS BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
10μ CYCLONE DUST
TRANSFER DUST TO LABELED POLYETHYLENE JAR
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
CONNECTOR TUBE AND 2μ CYCLONE
RINSE AND BRUSH WITH 1:1 METHANOL/METHYLENE CHLORIDE
TRANSFER WASHINGS TO LABELED AMBER GLASS BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
3μ CYCLONE DUST
TRANSFER DUST TO LABELED POLYETHYLENE JAR
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
CONNECTOR TUBE AND 1μ CYCLONE
RINSE AND BRUSH WITH 1:1 METHANOL/METHYLENE CHLORIDE
TRANSFER WASHINGS TO LABELED AMBER GLASS BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
1μ CYCLONE DUST
TRANSFER DUST TO LABELED POLYETHYLENE JAR
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
CONNECTOR TUBE AND FILTER HOLDER
RINSE AND BRUSH WITH 1:1 METHANOL/METHYLENE CHLORIDE
TRANSFER WASHINGS TO LABELED AMBER GLASS BOTTLE
GLASS FIBER FILTERS
TRANSFER FILTER TO SEPARATE LABELED PETRI DISH
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE

TABLE 6. SASS TRAIN SAMPLE RECOVERY PROCEDURES


TEFLON HOSE AND INTERNAL SURFACES OF ORGANIC MODULE
RINSE AND BRUSH WITH METHYLENE CHLORIDE
TRANSFER WASHINGS TO LABELED AMBER GLASS BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
XAD 2 CARTRIDGE
TRANSFER XAD 2 TO AMBER GLASS JAR
RINSE CARTRIDGE WITH METHYLENE CHLORIDE
TRANSFER WASHINGS TO LABELED AMBER GLASS JAR CONTAINING XAD 2
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
TEFLON HOSE
RINSE WITH 1:1 IPA/DI WATER
TRANSFER WASHINGS TO LABELED AMBER GLASS BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
IMPINGER #1
MEASURE VOLUME AND RECORD
RINSE CONNECTOR, STEM BOTTLE WITH 1:1 IPA/DI WATER
TRANSFER IMPINGER CONTENTS TO LABELED POLYETHYLENE BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
IMPINGER #2, #3
MEASURE VOLUME AND RECORD
RINSE CONNECTOR, STEM BOTTLE WITH 1:1 IPA/DI WATER
TRANSFER IMPINGER CONTENTS TO LABELED POLYETHYLENE BOTTLE
SEAL FOR SHIPMENT TO RESEARCH TRIANGLE INSTITUTE
IMPINGER #4
WEIGH SILICA GEL AND DISCARD

*NO CONDENSATE COLLECTED IN GLASS CONDENSATE JAR

TABLE 7. SASS TRAIN SAMPLE RECOVERY PROCEDURES

TABLE 8. SCRAP AND HOT METAL ADDITION

Date	Heat No.	Scrap Addition[a]			Hot Metal Addition[a]		Sampling Time
		Pit Scrap	Ingot Butts	Butts	Ladle 1	Ladle 2	
3/15/78	20764	20,000	--	83,000	201,000	212,000	3:44:05 pm - 3:45:25 pm 3:48 pm - 3:48:40 pm
	20765	20,000	--	84,000	200,000	211,400	4:33:50 pm - 4:35:50 pm 4:40:10 pm - 4:41 pm
	20766	20,000	10,000	72,000	201,000	211,000	5:39:20 pm - 5:40:25 pm 5:43:50 pm - 5:44:30 pm
	20767	20,000	10,000	74,000	209,000	200,000	6:38:50 pm - 6:40:05 pm 6:43:43 pm - 6:44:30 pm

[a]All values in lbs.

4.0 TEST RESULTS

4.1 ON-SITE RESULTS

The Acurex Corporation acquired the data at the sampling site (Table 9). The overall sampling rate was near isokinetic (104 percent). Eight separate periods of hot metal addition to scrap were sampled over a period of three hours for a total sampling time of 8.8 minutes. Gas volume collected was 1.027 m^3 well below the 30 m^3 (1,000 ft^3) recommended by Level 1 protocol because of the shortness (about 1 minute) of the hot metal addition periods.

No on-site gas analyses for low molecular weight organics or inorganic species were made.

TABLE 9. SUMMARY OF SAMPLING DATA FOR Q-BOP SHOP REPUBLIC STEEL, CHICAGO, ILLINOIS

Date of Test:	3/15/78
Volume of Gas Sampled:	36.2578 dscf
Stack Gas Temperature:	151.7°F
Stack Gas Pressure:	29.05 inches Hg
Stack Gas Dry Molecular Weight:	28.96 lb/lb-mole
Stack Gas Wet Molecular Weight:	28.73 lb/lb-mole
Stack Gas Moisture:	2.07%
Stack Gas Velocity:	104.5 ft/sec (single point)
Stack Gas Volumetric Flowrate:	405,812 dscfm[a]
Total Sampling Time:	8.8 minutes
SASS Train Flowrate:	4.12 dscfm
% Isokinetic:	104.0

[a]Average flowrate measured during preliminary tests was 330,887 dscfm, which is consistent with design value for system.

4.2 ANALYSIS OF SASS SAMPLES

Data presented in this Section are results of analyses performed by Research Triangle Institute. Table 10 shows the sample code used. Figure 6 shows the analysis procedure used for each sample.

TABLE 10. SAMPLE CODE

1C10	>10 micron cyclone dust
1C3	3-10 micron cyclone dust
1C310	Combined 1C10 and 1C3
1C1	1-3 micron cyclone dust
1F	<1 μ filter
1C1F	Combined 1C1 and 1F
1PW	Probe and cyclone rinses
1X	XAD-2 resin and organic module rinse
1IMP1	1st impinger
1IMP23	Combined 2nd and 3rd impinger

4.2.1 Total Particulate Loading

The total mass of particulates in the Q-BOP secondary emission control system (before any air pollution control equipment) and the concentration are given in Table 11. Of the 1300 mg/m^3 total particulates, 68.7 percent is greater than 10 μ in size, and 14 percent was captured by the 1 μ cyclone. Only two percent was captured by the filter (<1 μ size).

4.2.2 Level I Organic Analysis

Total organic material extracted from the various SASS train components is summarized in Table 12. About half of the total organic captured is associated with the less than 3 μ dust (1 μ cyclone and filter). Thus the average composition of these dusts is about 15.7 percent organic material. This is particularly interesting since no organic material was found in the >3 μ particles. The organic material on the dusts is about 58 percent GRAV

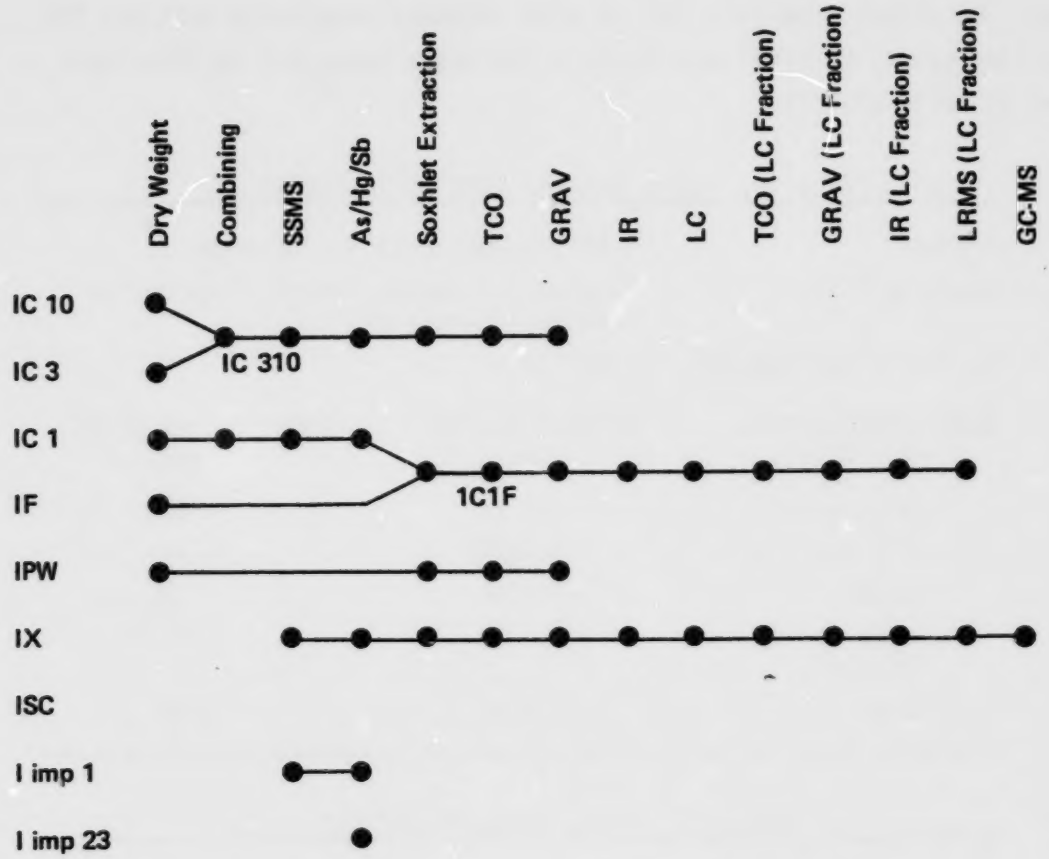


Figure 5. Analytical Procedures.

(high boiling point) material. (It is also somewhat surprising that any TCO (low boiling point) material was found on the dusts since the cyclones were operated at 204°C (400°F).

TABLE 11. TOTAL MASS OF EMITTED PARTICLES

Process:	Q-BOP, Republic Steel, Chicago, IL
Sampling Point:	Secondary Emission Control Duct During Hot Metal Addition
Volume of Gas Sampled:	1.027 dscm

Total Particulates	Grams Captured	Concentration mg/m^3
10 μ cyclone	0.9163	892
3 μ cyclone	0.0713	69
1 μ cyclone	0.1874	182
Filter	0.0264	26
Probe and Cyclone Rinses	0.1320	129
Total	1.3334	1298

TABLE 12. TOTAL ORGANICS EMITTED

Process:	Q-BOP, Republic Steel, Chicago, IL
Sampling Point:	Secondary Emission Control Duct During Hot Metal Addition
Volume of Gas Sampled:	1.027 dscm

Total Organics	mg/m^3
1C310	0.0
1C1F	32.6
1X	20.5
Probe and Cyclone Rinses	11.0
Total	64.1

About 32 percent of the organic material was captured by the XAD-2 resin. About 96 percent of the material was GRAV (high boiling point).

The organic extract from 1C1F (1 μ cyclone and <1 μ filter) were fractioned by liquid chromatography into seven fractions. Each fraction was analyzed for TCO (total chromatographical organics) and GRAV as well as by IR and LRMS. The LC, IR, and LRMS data are given in The Appendixes. From these data the organic species in each extract were classified into compound categories and the concentration of each category estimated. Concentration estimates are based on GRAV material only since Level 1 procedures remove TCO before IR or LRMS spectra are obtained. Strong peaks in the IR and LRMS were assigned intensity factors of 100; weak peaks were assigned intensities of 10. The GRAV concentration in mg/m^3 was then apportioned to each compound category according to its intensity factor so that the sum for all categories in a specific LC fraction equalled the GRAV concentration for that fraction. Tables 13 and 14 present these results.

Interesting aspects of the data are:

1. Aliphatic hydrocarbons are the predominate category in both samples.
2. Fused aromatics (MW >216) are the second major category for the <3 μ dusts.
3. The emissions contain a wide variety of compounds including carboxylic acids, esters, amides, and alcohols.
4. The LRMS data (Appendix A) contains several molecular weight identifications characteristic of known carcinogens however, GC-MS shows that these are due to fragments of high molecular weight aliphatics.

4.2.3 GC-MS Analysis

Although 1C1F (2μ cyclone and filter) contains an appreciable quantity of fused aromatic material, the M/ℓ^+ LRMS analysis indicates that none of the material corresponds to known carcinogens. Sample 1x (the x AD-Z resin extract), although containing appreciably less fused aromatic than 1C1F, does have several LRMS M/ℓ^+'s that correspond to known carcinogens and these components are found in LC fractions 2 and 3.

These LC fractions were combined and a single GC-MS run made. A 1.5 M column packed with 1 percent Dexel 300 was used in the GC. Single ion plots were obtained for M/ℓ^+'s of 178, 202, 252, 278, and 300. Retention times in the GC and the MS spectra obtained strongly indicate that the sample contained primarily aliphatic hydrocarbons. No carcinogenic compounds were identified. The components actually eluted were not identified. The total ion plat is in the Appendix.

4.2.4 Inorganic Analysis

Atomic absorption analysis of the samples are presented in Table 15, arsenic, mercury, and antimony were near or below detection limits for all samples.

The Spark Source Mass Spectrographic (SSMS) analyses of the same samples, however, show a much higher emission level of arsenic and antimony. A summary of the SSMS data is given in Table 16. Tables 17 through 21 give the SSMS data for each sample. The original data for the samples are given in Appendix A.

TABLE 13. ORGANIC EXTRACT SUMMARY

Sample 1C1F

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3	8.2	10.8	4.2	1.0	0.0	5.9	0.0	30.1
TCO, mg	2.1	9.0	0.0	0.0	0.0	0.0	0.0	11.1
GRAV, mg	6.3	2.1	4.3	1.0	0.0	6.1	0.0	18.8

Category	Int/mg/m^3 Based on GRAV weight only							
Aliphatics	100/5.5							5.5
Haloaliphalics	10/0.6	10/0.09						0.69
Substituted Benzenes		100/0.9	10/0.2					1.1
Halobenzenes		10/0.09	10/0.2					0.29
Fused Aromatics		100/0.9	100/3.8					4.7
Hetero N Compounds				100/0.2		10/0.1		0.3
Hetero O Compounds				100/0.2				0.2
Hetero S Compounds				100/0.2				0.2
Alkyl S Coumpounds						10/0.1		0.1
Nitriles				10/0.02				0.02
Aldehydes, Ketones				100/0.2				0.2
Nitro Aromatics				10/0.02				0.02
Ethers, Epoxides				100/0.2				0.2
Alcohols						100/1.1		1.1
Phenols						10/0.1		0.1
Amines						100/1.1		1.1

TABLE 13. (cont'd)

ORGANIC EXTRACT SUMMARY

Sample 1C1F

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3								
TCO, mg								
GRAV, mg								

Category	Int/mg/m^3							
Amides						100/1.1		1.1
Esters						100/1.1		1.1
Carboxylic Acids						100/1.1		1.1
Sulfonic Acids and Sulfoxides						10/0.1		0.1

TABLE 14. ORGANIC EXTRACT SUMMARY

Sample 1X - XAD-2 Sample and Module Rinse

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3	2.8	1.3	1.3	0.6	0.2	5.0	1.3	12.5
TCO, mg	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.7
GRAV, mg	2.9	1.3	0.6	0.6	0.2	5.1	1.3	12.0

Category	Int/mg/m^3							
Aliphatics	100/2.5							2.5
Haloaliphatics	10/0.3	100/0.3						0.6
Substituted Benzenes		100/0.3						0.3
Halobenzenes		10/0.3	100/0.15					0.18
Fused Aromatics		100/0.3	100/0.15					0.18
Hetero N Compounds				10/0.02	10/0.005	10/0.14		0.16
Hetero O Compounds				10/0.02	10/0.005			0.025
Hetero S Compounds				100/0.2	100/0.05			0.205
Alkyl S Compounds					10/0.005			0.005
Nitriles				100/0.2	10/0.005			0.205
Aldehydes, Ketones			100/0.15	100/0.2	100/0.05			0.4
Nitro Aromatics				10/0.02	10/0.005			0.025
Ethers, Epoxides		100/0.3	100/0.15	12/0.02	10/0.005			0.48
Alcohols					10/0.005	100/1.4	10/0.05	1.5
Phenols					10/0.005	10/0.14	100/0.5	0.64
Amines					10/0.005	10/0.14	10/0.05	0.20

TABLE 14. (cont'd)

ORGANIC EXTRACT SUMMARY

Sample IX - XAD-2 Sample and Module Rinse

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3								
TCO, mg								
GRAV, mg								

Category	Int/mg/m^3							
Amides					10/0.005	10/0.14	10/0.05	0.20
Esters				10/0.02	100/0.05	100/1.4	10/0.05	1.50
Carboxylic Acids						100/1.4	100/0.5	1.9
Sulfonic acids and Sulfoxides						10/0.14	10/0.05	0.19

TABLE 15. ARSENIC, MERCURY AND ANTIMONY BY ATOMIC ABSORPTION SPECTROSCOPY

Sample	As	Hg	Sb
	mg/m^3		
Probe and Cyclone Rinses	<0.00064	<0.0000064	<0.000019
1C310	<0.00009	<0.0031	<0.00014
1-3 μ cyclone	<0.00009	<0.000009	<0.000027
1X	0	0	0
1IMP1	0	0	0
1IMP23	0	0	0
Total	<0.00063	<0.0031	<0.0019

TABLE 16. TOTAL INORGANICS BY SPARK SOURCE MASS SPECTROMETRY

Element	Air Health MATE Values or Range, mg/m^3	At Source Mass/Volume mg/m^3 or $\mu g/L$	Percent Control Needed
Copper	0.2	0.10	0
Nickel	0.015	0.18	92
Cobalt	0.05	<0.0043	0
Iron	0.7-9.0	85.3	99-89
Manganese	5.0	3.8	0
Chromium	0.001	0.26	99.6
Vanadium	0.5	<0.042	0
Titanium	6.0	0.13	0
Scandium			
Calcium	16	64.	75
Potassium	2	0.92	0
Chlorine			
Sulphur	1-440	7.9	0-87
Phosphorus	0.1-1.0	0.53	0-81
Silicon	10	4.2	0
Aluminum	5.2-10	0.43	0
Magnesium	6-10	2.3	0
Sodium	2-53	0.056	0
Fluorine			
Oxygen			
Nitrogen			
Carbon			
Boron	3-10	0.013	0
Beryllium	0.002	0.000064	0
Lithium	0.022	0.00073	0
Hydrogen			

TABLE 16. (cont'd)

Element	Air Health Mate Values or Range, mg/m^3	At Source Mass/Volume mg/m^3 or $\mu g/L$	Percent Control Needed
Cerium	37	<0.00081	0
Lanthanum	110	<0.0012	0
Barium	0.5	0.020	0
Cesium	82	<0.00008	0
Iodine		<0.00059	
Tellurium		<0.0011	
Antimony	0.5	<0.0010	0
Tin	10	0.0038	0
Indium		IS	
Cadmium	0.01	0.0022	0
Silver			
Palladium		<0.00053	
Rhodium		<0.000063	
Ruthenium		<0.00045	
Molybdenum	5.0	0.026	0
Niobium	22	<0.0065	0
Zirconium	5.0	<0.011	0
Yttrium	1.0	0.0015	0
Strontium	3.1	<0.056	0
Rubidium	120	<0.0012	0
Bromine	10	<0.032	0
Selenium	0.2	<0.033	0
Arsenic	0.002	0.021	90
Germanium	0.56	0.0015	0
Gallium	0.50	<0.0029	0
Zinc	4.0	0.14	0

TABLE 16. (cont'd)

Element	Air Health MATE Values or Range, mg/m^3	At Source Mass/Volume mg/m^3 or $\mu g/L$	Percent Control Needed
Uranium			
Thorium			
Bismuth		<0.0007	
Lead	0.15	0.41	63
Thallium			
Mercury			
Gold			
Platinum			
Iridium			
Osmium			
Rhenium			
Tungsten		0.0011	
Tantalum			
Hafnium			
Lutecium			
Ytterbium			
Thulium			
Erbium		<0.000032	
Holmium			
Dysprosium	9.3	<0.0002	0
Terbium		<0.000021	
Gadolinium		<0.000037	
Europium		<0.000009	
Samarium		<0.00039	
Neodymium		<0.00061	
Praseodymium	51	<0.0001	0

TABLE 17. SSMS ANALYSIS SHEET

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 1978

Type of Source: Q-BOP Secondary Emission dust during hot metal addition

Test Number: Sample ID Number: 1 PW

Sample Description: Particulate from nozzle and probe wash

Responsible Analyst: GCA Date Analyzed:

Calculations and Report Reviewed By: Report Date:

Instrument: Resolution:

Internal Standard(s):

Original Sample Volume or Mass: 0.054 g tested (0.132 gms at source)

Dilution Factor:

Brief Description of Electrode Preparation:

TABLE 17. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper							62.0	0.008
Nickel							750.0	0.096
Cobalt							12.0	0.0015
Iron							9.4 (%)	12.1
Manganese							0.23 (%)	0.30
Chromium							0.13 (%)	0.17
Vanadium							21.0	0.0027
Titanium							12.0	0.0015
Scandium								
Calcium							2.6 (%)	3.34
Potassium							150.0	0.019
Chlorine								
Sulphur							0.27 (%)	0.35
Phosphorus							200.0	0.026
Silicon							0.64 (%)	0.92
Aluminum							0.11 (%)	0.14
Magnesium							1.3 (%)	1.67
Sodium							220.0	0.028
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron							29.0	0.0037
Beryllium							0.086	0.00001
Lithium							0.086	0.00001
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 17. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium							1.3	0.00017
Lanthanum							0.68	0.000057
Barium							80.0	0.010
Cesium							<0.052	<0.0000067
Iodine							3.6	0.00046
Tellurium								
Antimony							1.5	0.00019
Tin							12.0	0.0015
Indium							IS	
Cadmium							7.2	0.00093
Silver								
Palladium							0.73	0.000094
Rhodium								
Ruthenium							<0.47	<0.00006
Molybdenum							150.0	0.0193
Niobium							0.90	0.00012
Zirconium							3.4	0.00044
Yttrium							0.70	0.00009
Strontium							52.0	0.0067
Rubidium							1.2	0.00015
Bromine							15.0	0.0019
Selenium							<12.0	<0.0015
Arsenic							49.0	0.0063
Germanium							4.1	0.00053
Gallium							5.0	0.00064
Zinc							290.0	0.037

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 17. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth							1.2	0.00015
Lead							410.0	0.053
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten							2.8	0.00036
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium							<0.25	<0.000032
Holmium								
Dysprosium							<0.33	<0.000042
Terbium							<0.16	<0.000021
Gadolinium							<0.29	<0.000037
Europium							<0.071	<0.000009
Samarium							<1.0	<0.00013
Neodymium							1.3	0.00017
Praseodymium							<0.16	<0.000021

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank)

TABLE 18. SSMS ANALYSIS SHEET

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 1978

Type of Source: Q-BOP Secondary Emission Dust During Hot Metal Addition

Test Number: _____ Sample ID Number: 1C310

Sample Description: 3-10 μ and <10 μ Cyclone Catches

Responsible Analyst: GCA Date Analyzed: _____

Calculations and Report Reviewed By: _____ Report Date: _____

Instrument: _____ Resolution: _____

Internal Standard(s): _____

Original Sample Volume or Mass: 0.0730g (0.9876 at source)

Dilution Factor: _____

Brief Description of Electrode Preparation: _____

TABLE 18. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper							15.	0.014
Nickel							14.	0.013
Cobalt							1.7	0.0016
Iron							7.6 (%)	73
Manganese							0.35 (%)	3.4
Chromium							76.	0.073
Vanadium							39.	0.038
Titanium							120.	0.115
Scandium								
Calcium							2.7 (%)	26.0
Potassium							45.	0.043
Chlorine								
Sulphur							390.	0.38
Phosphorus							150.	0.14
Silicon							0.32 (%)	3.1
Aluminum							230.	0.22
Magnesium							670.	0.64
Sodium							8.3	0.008
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron							6.5	0.0063
Beryllium							0.026	0.000025
Lithium							0.12	0.00012
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 18. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium							0.46	0.00044
Lanthanum							0.94	0.00090
Barium							7.5	0.0072
Cesium							0.028	0.000027
Iodine							0.071	0.000068
Tellurium							< 0.68	<0.00065
Antimony							0.55	0.00053
Tin							1.3	0.0013
Indium							IS	IS
Cadmium							0.12	0.00012
Silver								
Palladium							< 0.25	<0.00024
Rhodium							< 0.066	<0.000063
Ruthenium							< 0.41	<0.00039
Molybdenum							2.1	0.0020
Niobium							4.5	0.0043
Zirconium							3.9	0.0038
Yttrium							1.1	0.0011
Strontium							28.	0.027
Rubidium							0.56	0.00054
Bromine							26.	0.025
Selenium							<14.	<0.013
Arsenic							10.	0.0096
Germanium							< 0.50	<0.00048
Gallium							1.3	0.0013
Zinc							12.	0.012

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 18. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead							56.	0.054
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten							0.73	0.00070
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium							<0.17	<0.00016
Terbium								
Gadolinium								
Europium								
Samarium							<0.27	<0.00026
Neodymium							<0.35	<0.00024
Praseodymium							<0.083	0.000080

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (< 2σ blank)

TABLE 19. SSMS ANALYSIS SHEET

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 1978

Type of Source: Q-BOP Secondary Emission Dust During Hot Metal Addition

Test Number: Sample ID Number: 1C1

Sample Description: 1-3 μ Cyclone Catch

Responsible Analyst: GCA Date Analyzed:

Calculations and Report Reviewed By: Report Date:

Instrument: Resolution:

Internal Standard(s):

Original Sample Volume or Mass: 0.0165g

Dilution Factor:

Brief Description of Electrode Preparation:

TABLE 19. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper							26.	0.0047
Nickel							65.	0.012
Cobalt							2.2	0.00040
Iron							4.0	0.00073
Manganese							580.	0.106
Chromium							44.	0.0080
Vanadium							4.8	0.00088
Titanium							80.	0.015
Scandium								
Calcium							19. (%)	34.7
Potassium							190.	0.035
Chlorine								
Sulphur							0.65 (%)	1.2
Phosphorus							62.	0.011
Silicon							0.14 (%)	0.26
Aluminum							390.	0.071
Magnesium							0.94	0.00017
Sodium							110.	0.020
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron							14.	0.0026
Beryllium							0.16	0.000029
Lithium							3.3	0.00060
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 19. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium							<1.1	<0.00020
Lanthanum							<1.3	<0.00024
Barium							14.	0.0026
Cesium							<0.25	<0.000046
Iodine							<0.31	<0.000057
Tellurium							< 2.5	< 0.00046
Antimony							< 1.7	< 0.00031
Tin							5.7	0.0010
Indium							IS	IS
Cadmium							6.7	0.0012
Silver								
Palladium							< 1.1	< 0.0002
Rhodium								
Ruthenium								
Molybdenum							5.9	0.0011
Niobium							< 0.85	< 0.00016
Zirconium							9.2	0.0017
Yttrium							1.8	0.00033
Strontium							120.	0.022
Rubidium							2.4	0.00044
Bromine							< 9.5	< 0.0017
Selenium							< 7.9	< 0.0014
Arsenic							21.	0.0038
Germanium							2.5	0.00046
Gallium							4.5	0.00082
Zinc							500.	0.091

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 19. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium							<3.0	<0.00055
Bismuth							0.13 (%)	0.24
Lead								
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten								
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium							< 1.1	<0.0002
Neodymium								
Praseodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank)

TABLE 20. SSMS ANALYSIS SHEET

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 1978

Type of Source: Q-BOP Secondary Emission Dust During Hot Metal Addition

Test Number: Sample ID Number: 1 X and Blank

Sample Description: Parr bombed XAD-2 Resin and Blank

Responsible Analyst: GCA Date Analyzed:

Calculations and Report Reviewed By: Report Date:

Instrument: Resolution:

Internal Standard(s):

Original Sample Volume or Mass: 5.0 ml 130 grams at source

Dilution Factor: 25

Brief Description of Electrode Preparation:

1.0 grams resin Parr bombed and taken up in 25 ml of solution. 5.0 ml of solution used in test. Same procedure for sample and blank.

TABLE 20. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/l$
Copper		0.29	0.27	0.02			0.5	0.06
Nickel		0.039	0.096	NG			NG	
Cobalt		0.0007	0.0020	NG			NG	
Iron		0.31	0.28	0.03			0.75	0.095
Manganese		0.020	0.036	NG			NG	
Chromium		0.015	0.026	NG			NG	
Vanadium		0.0010	0.0018	NG			NG	
Titanium		0.012	0.016	NG			NG	
Scandium								
Calcium		0.63	0.71	NG			NG	
Potassium		0.49	0.23	0.26			6.5	0.82
Chlorine								
Sulphur		8.2	6.4	1.8			45	5.7
Phosphorus		0.11		0.11			2.8	0.35
Silicon		0.17	0.31	NG			NG	
Aluminum		0.27	1.1	NG			NG	
Magnesium		0.053	0.10	NG			NG	
Sodium		0.18	0.23	NG			NG	
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron		0.0013	0.0034	NG			NG	
Beryllium								
Lithium		0.0013	0.0017	NG			NG	
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (< 2σ blank).

TABLE 20. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium			0.0030	NG			NG	
Lanthanum								
Barium		0.010	0.019	NG			NG	
Cesium								
Iodine								
Tellurium								
Antimony								
Tin								
Indium		IS	IS	IS			IS	
Cadmium								
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum			0.0059	NG			NG	
Niobium		<0.0006		<0.0006			<0.015	<0.0019
Zirconium		<0.0016		<0.0016			<0.04	<0.0051
Yttrium								
Strontium		0.019	0.024	NG			NG	
Rubidium		0.0017	0.0031	NG			NG	
Bromine		0.010	0.0087	0.001			0.025	0.0032
Selenium		<0.0054		<0.0054			<0.135	< 0.017
Arsenic		0.0043	0.0040	0.0003			0.0075	0.00095
Germanium								
Gallium		< 0.0008	0.0010	NG			NG	
Zinc		0.70	0.91	NG			NG	

*Results: PPM value (in original sample) or I - Interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 20. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead		0.043	0.024	0.019			0.48	0.061
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten								
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium								
Prascodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank)

TABLE 21. SSMS ANALYSIS SHEET

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 1978

Type of Source:

Test Number: Sample ID Number: 2553-1-J

Sample Description: First Impinger Solution

Responsible Analyst: Date Analyzed:

Calculations and Report Reviewed By: Report Date:

Instrument: Resolution:

Internal Standard(s):

Original Sample Volume or Mass: 20.0 ml 870 ml at source

Dilution Factor:

Brief Description of Electrode Preparation:

TABLE 21. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper		0.021	0.0036	0.017			0.017	0.014
Nickel		0.074	0.0023	0.072			0.072	0.061
Cobalt		0.0009	0.0001	<0.0009			<0.0009	<0.0008
Iron		0.11	0.027	0.08			0.08	0.07
Manganese		0.014	0.0013	0.013			0.013	0.011
Chromium		0.017	0.0010	0.016			0.016	0.014
Vanadium		0.0001	<0.0001	<0.0001			<0.0001	<0.0001
Titanium		0.0003	0.0011	NG			NG	
Scandium								
Calcium		0.022	0.18	NG			NG	
Potassium		0.011	0.015	NG			NG	
Chlorine								
Sulphur		0.38	0.044	0.34			0.34	0.29
Phosphorus		0.0020	0.0034	NG			NG	
Silicon		0.12	0.16	NG			NG	
Aluminum		0.0094	0.0059	0.0035			0.0035	0.0030
Magnesium		0.0046	0.0051	NG			NG	
Sodium		0.16	0.45	NG			NG	
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron		0.0015	0.0026	NG			NG	
Beryllium								
Lithium		<0.0001	<0.0001	0			0	
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($< 2\sigma$ blank).

TABLE 21. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium								
Lanthanum								
Barium		0.0007	0.0018	NG			NG	
Cesium								
Iodine								
Tellurium								
Antimony								
Tin		< 0.0005	< 0.0019	NG			NG	
Indium		IS	IS	IS			IS	
Cadmium								
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum		0.0038		0.0038			0.0038	0.0032
Niobium								
Zirconium								
Yttrium								
Strontium		< 0.0003		< 0.0003			< 0.0003	< 0.0003
Rubidium		< 0.0001		< 0.0001			< 0.0001	< 0.0001
Bromine		< 0.0005	0.0017	NG			NG	NG
Selenium								
Arsenic		< 0.0001		< 0.0001			< 0.0001	< 0.0001
Germanium								
Gallium		0.0001		0.0001			0.0001	0.0001
Zinc		0.0067	0.0043	0.0024			0.0024	0.0020

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 21. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead		0.0014	0.0090	NG			NG	
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten		0.0062	0.16	NG			NG	
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium								
Praseodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank)

APPENDIX A

LEVEL I ORGANIC ANALYSES OF SAMPLE 1C1F, IX, AND INORGANIC ANALYSIS DATA

TABLE A-1. LC ANALYSIS REPORT

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 15, 1978

Type of Source: Q-BOP, Secondary Emission Dust

Test Number: 1 Sample ID Number: 1C1F

Sample Description: Uncontrolled Emissions During Hot Metal Addition

Original Sample Volume or Mass: 0.2138 gms (0.0982 gm extracted - 45.9% each catch)

Responsible Analyst: J. Cortese Date Analyzed: _____

Calculations and Report Reviewed By: Handy, Westbrook Report Date: _____

Column Flow Rate: _____ Column Temperature: _____

Observations: _____

	TCO mg	GRAV mg	Total mg	Concentration[5] mg/M^3
Total Sample[1]	13.9	19.6	33.5	32.6
Taken for LC[2]	5.4	7.7	13.1	12.8
Recovered[3]	4.3	7.8	12.1	11.8

Fraction	TCO[4] in mg			GRAV[4] in mg			Total[4] mg	Concentration[5] mg/M^3
	Total	Blank	Corrected	Total	Blank	Corrected		
1	2.1	0.0	2.1	7.1	0.8	6.3	8.4	8.2
2	9.0	0.0	9.0	4.6	2.5	2.1	11.1	10.8
3	0.0	0.0	0.0	4.3	0.0	4.3	4.3	4.2
4	0.0	0.0	0.0	2.0	1.0	1.0	1.0	1.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	6.1	0.0	6.1	6.1	5.9
7	0.0	0.0	0.0	1.5	2.5	0.0	0.0	0.0
Sum	11.1	0.0	11.1	25.6	6.8	18.8	30.9	30.1

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Total mg divided by total volume

TABLE A-2. IR REPORT--SAMPLE NO. 1C1F, CUT LC-1

1 μ particulate and < 1 μ filter

Total Sample GRAV = 6.3 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2852-2954	S	CH, aliphatic	Aliphatics	100
1463	M	CH, aliphatic	Haloaliphatics	10
1376	M	CH, aliphatic		
810	W	CH, substituted		

TABLE A-3. IR REPORT--SAMPLE NO. 1C1F, CUT LC-2

1 μ particulate and < 1 μ filter

Total Sample GRAV = 2.1 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3035	M	CH, aromatic/ olefinic	Haloaliphatics	10
2872-2958	S	CH, aliphatic	Substituted benzenes	100
1602	W	C=C, aromatic	Halobenzenes	10
1456	S	CH, aliphatic	Fused aromatics	100
1377	S	CH, aliphatic		
748-976	M	CH, multiplet		

TABLE A-4. IR REPORT--SAMPLE NO. 1C1F, CUT LC-3

1 μ particulate and < 1 μ filter
Total Sample GRAV = 4.3 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3405	M	NH or OH*	Substitute Benzenes	100
3054	M	CH, aromatic	Halobenzenes	10
2860-2960	S	CH, aliphatic	Fused aromatics	100
1721	M	C=O, ketone/ester*		
1602, 1577	S	C=C, aromatic		
1502	S	C=C, aromatic		
1452	M	CH, aliphatic		
1402	S	Alcohol/phenol*		
1308	S	Aromatic amine*		
694-795	S	CH, multiplet		

*Contamination

TABLE A-5. IR REPORT--SAMPLE NO. 1C1F, CUT LC-4

1 μ particulate and < 1 μ filter
Total Sample GRAV = 1.0 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3375-3400	W	NH or OH*	Hetero N Compounds	100
3048	W	CH, aromatic	Hetero O Compounds	100
2854-2955	S	CH, aliphatic	Hetero S Compounds	100
1733	M	CO=O, ketone	Nitriles	10
1583, 1495	S	CH, aromatic	Ethers, Epoxides	100
1458, 1382	S	CH, aliphatic	Aldehydes, Ketones	100
1301	S	Aromatic amine*	Nitroaromatics	10
1157	M	COC, ether		
694, 756	S	CH, substitute		

*Contamination

TABLE A-6. IR REPORT--SAMPLE NO. 1C1F, CUT LC-5

1 μ particulate and < 1 μ filter

Quantity Not Sufficient

TABLE A-7. IR REPORT--SAMPLE NO. 1C1F, CUT LC-6

1 μ particulate and < 1 μ filter

Total Sample GRAV = 6.1 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3300-3400	W	NH or OH (broad)		
2859-2955	S	CH, aliphatic	Phenols	10
1719, 1701	S	Carboxylic acid/ ester	Esters	100
1570, 1600	W	Amide, Amine		100
1385, 1457	M	CH, aliphatic	Hetero N Compounds	10
1248-1272	M	COC, ester	Alkyl S Compounds	10
752	W	CH, substitute	Sulfonic Acids, Sulfoxides	10
			Carboxylic Acids	100
			Alcohols	100
			Amides	100

TABLE A-8. IR REPORT--SAMPLE NO. 1C1F, CUT LC-7

1 μ particulate and < 1 μ filter

Quantity Not Sufficient

TABLE A-9. LR MASS SPECTROSCOPY REPORT--SAMPLE 1C1F, CUT LC-1

1 μ particulate and < 1 μ filter

Categories	Relative Intensity
Aliphatics	100
Haloaliphatics	1

TABLE A-10. LR MASS SPECTROSCOPY REPORT--SAMPLE 1C1F, CUT LC-2

1 μ particulate and < 1 μ filter

Sample Weight Quantity Not Suitable For Analysis

TABLE A-11. LR MASS SPECTROSCOPY REPORT--SAMPLE 1C1F, CUT LC-3

1 μ particulate and < 1 μ filter

Categories		Relative Intensity
Substitute Benzenes		1
Halobenzenes		1
Fused Aromatics (MW < 216)		1
Fused Aromatics (MW > 216)		100
Possible Identifications	Mol. Wt.	Relative Intensity
Indenopyrene, Benzoperylene	276	10

Strong hydrocarbon peaks observed between m/e + 300 and 486.

TABLE A-12. LR MASS SPECTROSCOPY REPORT--SAMPLE 1C1F, CUTS LC-4-7

1 μ particulate and < 1 μ filter

Sample weights of LC 4, 5 and 7 were Quantity Not Suitable for analysis.

Mass spectra of LC fraction 6 was too complex for unequivocal category identification.

TABLE A-13. LC ANALYSIS REPORT

Contractor: Research Triangle Institute

Sample Site: Republic Steel, Chicago, IL Sample Acquisition Date: March 1978

Type of Source: Q-BOP. Secondary Emission Dust

Test Number: 1 Sample ID Number: 1X + Module Rinse

Sample Description: Uncontrolled Emissions During Hot Metal Addition

Original Sample Volume or Mass: 130 gms.

Responsible Analyst: J. Cortese Date Analyzed: _____

Calculations and Report Reviewed By: Handy, Westbrook Report Date: _____

Column Flow Rate: _____ Column Temperature: _____

Observations: _____

	TCO mg	GRAV mg	Total mg	Concentration[5] mg/M^3
Total Sample[1]	0.8	20.3	21.1	20.5
Taken for LC[2]	0.7	17.0	17.7	17.2
Recovered[3]	0.6	10.1	10.7	10.4

Fraction	TCO[4] in mg			GRAV[4] in mg			Total[4] mg	Concentration[5] mg/M^3
	Total	Blank	Corrected	Total	Blank	Corrected		
1	0.0	0.0	0.0	3.1	0.2	2.9	2.9	2.8
2	0.0	0.0	0.0	1.3	0.0	1.3	1.3	1.3
3	0.7	0.0	0.7	0.6	0.0	0.6	1.3	1.3
4	0.0	0.0	0.0	0.6	0.0	0.6	0.6	0.6
5	0.0	0.0	0.0	0.2	0.0	0.2	0.2	0.2
6	0.0	0.0	0.0	5.1	0.0	5.1	5.1	5.0
7	0.0	0.0	0.0	1.3	0.0	1.3	1.3	1.3
Sum	0.7	0.0	0.7	12.2	0.2	12.0	12.7	12.5

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Total mg divided by total volume

TABLE A-14. IR REPORT--SAMPLE NO. 1X, CUT LC-1

XAD-2 Resin

Total Sample GRAV = 2.9 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2854-2955	S	CH, aliphatic	Aliphatics	100
1456	M	CH, aliphatic	Haloaliphatics	10
1376	M	CH, aliphatics		

TABLE A-15. IR REPORT--SAMPLE NO. 1X, CUT LC-2

XAD-2 Resin

Total Sample GRAV = 1.3 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2861-2955	S	CH, alipatic	Fused Aromatics	100
1739	S	C=O, ester or ketone	Ester or Ketone	100
1263	S	COC or CX, aliphatic (X=Halogen)	Haloaromatic	10
1033, 1094	S	COC	Ether	100
1456	S	CH, aliphatic	Substituted	100
1376	M	CH, aliphatic	Benzenes	
806		Aliphatic		
700		Aliphatic		

TABLE A-16. IR REPORT--SAMPLE NO. 1X, CUT LC-3

XAD-2 Resin

Total Sample GRAV = 0.6 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2861-2955	S	CH, aliphatic	Fused Aromatics	100
1739	S	C=O	Ester, Ketone	100
1263	S	COC or CX aliphatic (X=Halogen)	Haloaromatics	100
1033, 1094	S	COC	Ether	100
1456	S	CH, aliphatic		
1376	M	CH, aliphatic		
806	S	Aliphatic		
700	S	Aliphatic		

TABLE A-17. IR REPORT--SAMPLE NO. 1X, CUT LC-4

XAD-2 Resin

Total Sample GRAV = 0.6 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2857-2962	S	CH, aliphatic	Hetero S Compounds	100
1735	S	C=O	Nitrile	100
1461	S	CH, aliphatic	Aldehyde, Ketone	100
1274	M	Ester or CX (X=Halogen)	Ester	10
1116	W	COC ether	Ether	10
1379		CH, aliphatic		
702, 667		Aliphatic		

TABLE A-18. IR REPORT--SAMPLE NO. 1X, CUT LC-5

XAD-2 Resin

Total Sample GRAV = 0.2 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2861-2961	S	CH, aliphatic	Hetero S Compounds	100
1739	S	C=O, ester or ketone	Ketone	100
1456, 1376	M	CH, aliphatic	Aldehyde, Ketone	100
1263	S	COC or C-Halogen	Ester	100
1025, 1075, 1119	M	COC	Ether	10
700-806	M	Aliphatic		

TABLE A-19. IR REPORT--SAMPLE NO. 1X, CUT LC-6

XAD-2 Resin

Total Sample GRAV = 5.1 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2500-3400	M	Carboxylate OH bonded	Carboxylic Acid	100
3300-3400	M	NH or OH (broad)	Carboxylic Acid	
1700, 1725	S	Carboxylic acid, ester, CO ketone	Carboxylic Acid	
1556	M	Carboxylate ion		
1275	S	Carboxylic acid, ester or alkyl-halide	Ester	100
1124	S	COC, ether or COH, alcohol	Alcohol	100
1456, 1381	S	CH, aliphatic		
711	S	Aliphatic		

TABLE A-20. LR MASS SPECTROSCOPY REPORT--SAMPLE IX, CUT LC-1

XAD-2 Sample and Module Rinse

Categories	Relative Intensity
Aliphatics	100
Haloaliphatics	1

TABLE A-21. LR MASS SPECTROSCOPY REPORT--SAMPLE IX, CUT LC-2

XAD-2 Sample and Module Rinse

Categories		Relative Intensity
Haloaliphatics		1
Substitute Benzenes		100
Halobenzenes		1
Fused Aromatics (MW < 216)		100
Fused Aromatics (MW > 216)		10
Possible Identifications	Mol. Wt.	Relative Intensity
Naphthalene	128	10
Phenanthrarene, anthracene	178	100
Fluoranthene, pyrene	202	100
Benzoflouranthene, benzopyrene	252	10

Intense hydrocarbon peaks observed between m/e + 358 and 666.

TABLE A-22. LR MASS SPECTROSCOPY REPORT--SAMPLE IX, CUT LC-3

XAD-2 Sample and Module Rinse

Categories		Relative Intensity
Substitute Benzenes		10
Halobenzenes		1
Fused Aromatics (MW < 216)		1
Fused Aromatics (MW > 216)		10
Possible Identifications	Mol. Wt.	Relative Intensity
Dibenzanthracene	278	10

Strong hydrocarbon peaks observed between m/e + 358 and 600.

TABLE A-23. LR MASS SPECTROSCOPY REPORT--SAMPLE IX, CUT LC-4-7

XAD-2 Sample and Module Rinse

Sample weights of LC 4 and 5 were Quantity Not Suitable for analysis.

Mass spectra of LC fractions 6 and 7 were too complex for unequivocal category identification.

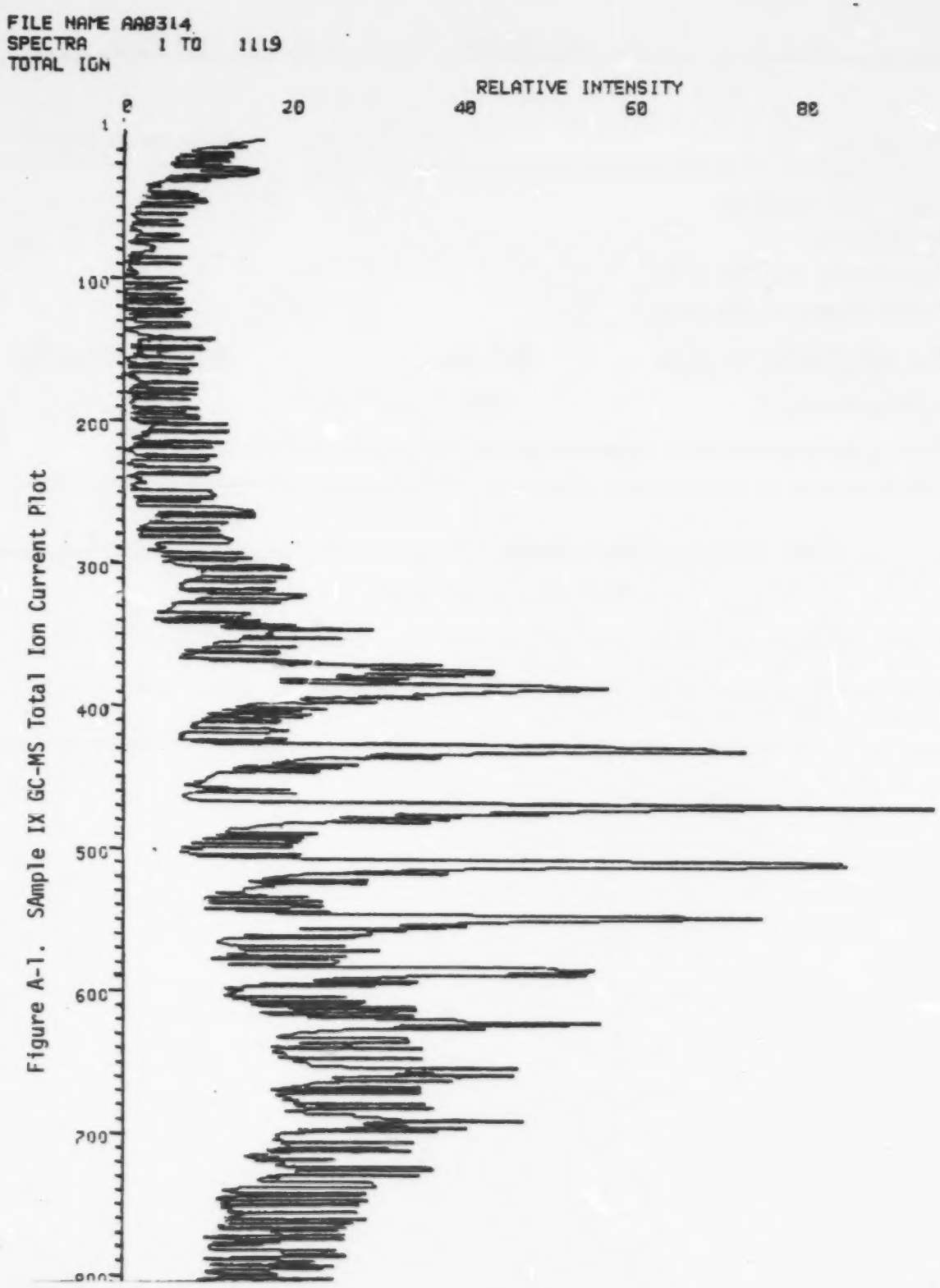


Figure A-1. SAmple IX GC-MS Total Ion Current Plot

TABLE A-24. SSMS ANALYSIS OF SAMPLE NO. 1 PW

(0.054 G) Particulate From Nozzle and Probe Wash

Element	Value (ppm)	Element	Value (ppm)
BI	1.2	RB	1.2
PB	410	BR	15
W	2.8	SE	< 12
ER	< 0.25	AS	49
DY	< 0.33	CE	4.1
TB	< 0.16	GA	5
GD	< 0.29	ZN	290
EU	< 0.071	CU	62
SM	< 1.0	NI	750
ND	1.3	CO	12
PR	< 0.16	FE	9.4 (%)
CE	1.3	MN	0.23(%)
LA	0.68	CR	0.13(%)
BA	80	V	21
CS	< 0.052	TI	12
I	3.6	CA	2.6 (%)
SB	1.5	K	150
SN	12	S	0.27(%)
IN	IS*	P	200
CD	7.2	SI	0.64(%)
PD	0.73	AL	0.11(%)
RU	< 0.47	MG	1.3 (%)
MO	150	NA	220
NB	0.90	B	29
ZR	3.4	BE	0.086
Y	0.70	LI	0.086
SR	52		

*IS - indicates the element is an internal standard

TABLE A-25. SSMS ANALYSIS OF SAMPLE NO. 1C310

(0.0730 G) 3-10 μ and > 10 μ Cyclone Catches

Element	Value (ppm)	Element	Value (ppm)
PB	56	BR	26
W	0.73	SE	< 14
DY	< 0.17	AS	10
SM	< 0.27	GE	< 0.50
ND	< 0.35	GA	1.3
PR	< 0.083	ZN	12
CE	0.46	CU	15
LA	0.94	NI	14
BA	7.5	CO	1.7
CS	0.028	FE	7.6 (%)
I	0.071	MN	0.35(%)
TE	< 0.68	CR	76
SB	0.55	V	39
SN	1.3	TI	120
IN	IS*	CA	2.7 (%)
CD	0.12	K	45
PD	< 0.25	S	390
RH	< 0.066	P	150
RU	< 0.41	SI	0.32(%)
MO	2.1	AL	230
NB	4.5	MG	670
ZR	3.9	NA	8.3
Y	1.1	B	6.5
SR	28	BE	0.026
RB	0.56	LI	0.12

*IS - indicates the element is an internal standard

TABLE A-26. SSMS ANALYSIS OF SAMPLE NO. 1C1F

(0.0165 G) 1-3 μ Cyclone Catch

Element	Value (ppm)	Element	Value (ppm)
BI	< 3.0	GE	2.5
PB	0.13(%)	GA	4.5
ND	< 1.1	ZN	500
CE	< 1.1	CU	26
LA	< 1.3	NI	65
BA	14	CO	2.2
CS	< 0.25	FE	4.0
I	< 0.31	MN	580
TE	< 2.5	CR	44
SB	< 1.7	V	4.8
SN	5.7	TI	80
IN	IS*	CA	19 (%)
CD	6.7	K	190
PD	< 1.1	S	0.65(%)
MO	5.9	P	62
NB	< 0.85	SI	0.14(%)
ZR	9.2	AL	390
Y	1.8	MG	0.94
SR	120	NA	110
RB	2.4	B	14
BR	< 9.5	BE	0.16
SE	< 7.9	LI	3.3
AS	21		

*IS - indicates the element is an internal standard

TABLE A-27. SSMS ANALYSIS OF SAMPLE NO. 1X

(5.0 ml) Parr Bombed XAD-2 Resin

Element	Value (ppm)	Element	Value (ppm)
PB	0.043	FE	0.31
BA	0.010	MN	0.020
IN	IS*	CR	0.015
NB	< 0.0006	V	0.0010
ZR	< 0.0016	TI	0.012
SR	0.019	CA	0.63
RB	0.0017	K	0.49
SE	< 0.0054	S	8.2
AS	0.0043	SI	0.17
GA	< 0.0008	AL	0.27
ZN	0.70	MG	0.053
CU	0.29	NA	0.18
NI	0.039	B	0.0013
CO	0.0007	LI	0.0013

*IS - indicates the element is an internal standard

TABLE A-28. SSMS ANALYSIS OF SAMPLE NO. 1X-BLANK

(5.0 ml) Parr Bombed XAD-2 Blank

Element	Value (ppm)	Element	Value (ppm)
PB	0.024	MN	0.036
CE	0.0030	CR	0.026
BA	0.019	V	0.0018
IN	IS*	TI	0.016
MO	0.0059	CA	0.71
SR	0.024	K	0.23
RB	0.0031	S	6.4
BR	0.0087	P	0.14
AS	0.0040	SI	0.31
GA	0.0010	AL	1.1
ZN	0.91	MG	1.1
CU	0.27	NA	0.23
NI	0.096	B	0.0034
CO	0.0020	LI	0.0017
FE	0.28		

*IS- indicates the element is an internal standard

TABLE A-29. SSMS ANALYSIS OF SAMPLE NO. 1IMP1

(20.0 ml) First Impinger Solution

Element	Value (ppm)	Element	Value (ppm)
PB	0.0014	FE	0.11
W	0.0062	MN	0.014
BA	0.0007	CR	0.017
SN	< 0.0005	V	0.0001
IN	IS*	TI	0.0003
MO	0.0038	CA	0.022
SR	< 0.0003	K	0.011
RB	< 0.0001	S	0.38
BR	< 0.0005	P	0.0020
SE	< 0.0005	SI	0.12
AS	0.0001	AL	0.0094
GA	< 0.0001	MG	0.0046
ZN	0.0067	NA	0.16
CU	0.021	B	0.0015
NI	0.074	LI	0.0001
CO	0.0009		

*IS - indicates the element is an internal standard

TABLE A-30. SSMS ANALYSIS OF SAMPLE NO. 1MP1-BLANK

(20.0 ml) First Impinger Blank (30% Peroxide Blank)

Element	Value (ppm)	Element	Value (ppm)
PB	0.0090	V	< 0.0001
W	0.16	TI	0.0011
BA	0.0018	CA	0.18
SN	< 0.0019	K	0.015
IN	IS*	S	0.044
BR	0.0017	P	0.0034
ZN	0.0043	SI	0.16
CU	0.0036	AL	0.0059
NI	0.0023	MG	0.0051
CO	< 0.0001	NA	0.45
FE	0.027	B	0.0026
MN	0.0013	LI	< 0.0001
CR	0.0010		

*IS - indicates the element is an internal standard

TABLE A-31. SSMS AVERAGE DETECTION LIMITS

Element	Value (μG)	Element	Value (μG)
U	0.040	RH	0.008
TH	0.058	RU	0.030
BI	0.018	MO	0.028
PB	0.037	NB	0.003
TL	0.022	ZR	0.013
AU	0.030	Y	0.005
IR	0.046	SR	0.007
OS	0.050	RB	0.002
RE	0.032	BR	0.040
W	0.043	SE	0.016
HF	0.053	AS	0.006
LU	0.012	GE	0.011
YB	0.018	GA	0.004
TM	0.011	ZN	0.006
ER	0.032	CU	0.005
HO	0.011	NI	0.004
DY	0.019	CO	0.002
TB	0.005	FE	0.002
GD	0.018	MN	0.002
EU	0.008	CR	0.002
SM	0.032	V	0.002
ND	0.040	TI	0.002
PR	0.007	CA	0.001
CE	0.010	K	0.001
LA	0.010	S	0.006
BA	0.014	P	0.002
CS	0.002	SI	0.001
I	0.028	AL	0.001
TE	0.023	MG	0.001
SB	0.016	NA	0.001
SN	0.023	B	0.001
IN	IS*	BE	0.001
CD	0.029	LI	0.001
PD	0.023		

*IS - indicates the element is an internal standard

APPENDIX B

OBSERVATIONS OF ACUREX AND RTI PERSONNEL

Acurex personnel (Steiner) and RTI personnel (Coy) reviewed the process data collection techniques during the first heat of the day (1:00 pm). RTI was also instructed in the use of the radio to alert Acurex, the sampling crew and the EPA Region V opacity observer when to start the actual test.

Operating problems with the bell valve in the quencher hindered Republic Steel personnel and delayed the heats. Finally, the problems were resolved and testing commenced at 3:30 pm. Dave Coy logged the following process data during heat 20764:

(1) Scrap Addition - 103,000 lbs.

pit scrap	20,000 lb.
butts	83,000 lb.

(2) Hot Metal Addition - Ladle 1 201,000 lbs.

Start 3:44:05 pm end 3:45:25 pm
good fume control; puff 10 to 15 seconds at end.

\- Ladle 2 212,000 lbs.

Start 3:48 pm end 3:48:40 pm
poorer fume control; 70 to 80 percent capture; fume exiting under ladle

(3) O_2 blow - start 3:49:25
end 4:04:21

clock blow time 14 min. 56 sec.
O_2 - 335,600 ft^3

(4) Hot Metal Transfer - Ladle 1 3:53 pm
Ladle 2 4:10 pm

(5) Turndown (for temp and sample) - 4:04:21 pm

(6) Rotate to Tap - start 4:19:30 pm
end 4:27:15 pm
tap emissions evident

(7) Slag - 4:30

During HMA -	Collection System No. 2	Collection System No. 1
Hood Pressure:	-04" H_2O	--
Quench Water:	2700 gpm	--
Stack Flow:	230,000 acfm	200,000 acfm
Scrubber Water:	2500 gpm	
Pressure Drop:	75" H_2O	

Sampling was conducted during hot metal addition only (both ladles) at the midpoint of the duct (5 feet from wall). The probe was removed from the duct after HMA and was sealed until the next heat.

Coy logged the following process data for heat 20765:

(1) Scrap Addition - 104,000 lbs 20,000 lb. pit scrap
84,000 lb. butts
- start 4:31:30 pm end 4:31:55 pm

(2) Hot Metal Addition - Ladle 1 200,000 lb
Start 4:33:50 pm end 4:35:50 pm
capture not good after 45 sec; fume escapes under ladle <90 percent capture; large red puff at end >50 percent capture

- Ladle 2 211,400 lb.
Start 4:40:10 pm end 4:41:00 pm
fume escapes under ladle; not bad until after 30 seconds.

(3) O_2 Blow - start 4:41:35 pm end 4:56:25 pm
clock blow time - 14 min. 43 sec.
O_2 - 331,900 ft^3

(4) Turndown (for temp and sample) - 4:56:30 pm

(5) Rotate to Tap - start 5:10:30 pm end 5:18:20 pm

(6) Hot Metal Transfer - Ladle 1 5:17 pm
Ladle 2 5:25:25 pm

During HMA -	Collection System No. 2	Collection System No. 1
Quench Water:	2700 gpm	-
Stack Flow:	230,000 acfm	200,000 acfm
Scrubber Water:	2500 gpm	--
Pressure Drop:	75" H_2O	--

Coy logged the following process data for heat 20766:

1) Scrap Addition - 102,000 lb 10,000 lb ingot butt
20,000 lb pit scrap
72,000 lb butts
- start 5:33:20 pm end 5:33:40 pm

(2) Hot Metal Addition - Ladle 1 201,000 lb
start 5:39:20 pm end 5:40:25 pm
good fume control except 5 to 10 sec. with minor fume under ladle
- Ladle 2 211,000 lb
start 5:43:50 pm end 5:44:30 pm

(3) O_2 Blow - start 5:45:05 end 6:00:01 pm
clock blow time 14 min. 56 sec.
O_2 - 335,700 ft^3

(4) Turndown (for temp. and sample) - 6:00:15 pm

(5) Rotate to Tap - start 6:13:00 pm end 6:21:00 pm

Coy recorded the following process data during heat 20767:

(1) Scrap Addition - 104,000 lb 10,000 lb ingot butt
20,000 lb pit scrap
74,000 lb butts
- start 6:24:25 pm end 6:24:57 pm

(2) Hot Metal Addition - Ladle 1 209,000 lbs
start 6:38:50 pm end 6:40:05 pm
fume control poor throughout pour; puff of red fume at end 50 to 75 percent capture
- Ladle 2 200,000 lbs
start 6:43:43 pm end 6:44:30 pm
fume control good for 15 sec. then poor until end ~50 to 70 percent capture

(3) O_2 Blow - start 6:45:10 pm end 7:00:00 pm
clock blow time 14 min. 40 sec.
O_2 - 331,800 ft^3

Acurex and RTI consulted with the Q-BOP operator at this point in time and learned there would be no more heats on this shift. The next shift came on at 11:00 pm. Furthermore, Republic Steel was planning to switch over from vessel No. 2 to vessel No. 1 the next morning which could take the entire day. A decision was made to recover the SASS sample that day rather than leave the sample sit in the sampling train overnight (and perhaps another day if vessel changeover was not successful).

Acurex took the SASS train to the sample recovery area and proceeded to recover the samples.